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Tokuda

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(54) **TRACTOR UNIT, CONVEYANCE DEVICE, AND PRINTER**

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B41J 13/00 (2006.01)
B41J 11/30 (2006.01)

(52) **U.S. Cl.**
CPC ***B65H 20/20*** (2013.01); ***B41J 11/30*** (2013.01); ***B41J 13/0009*** (2013.01); *B65H 2403/481* (2013.01); *B65H 2403/732* (2013.01)

(58) **Field of Classification Search**
CPC B41J 11/007; B41J 2/2114; B41J 11/42; B41J 11/48
See application file for complete search history.

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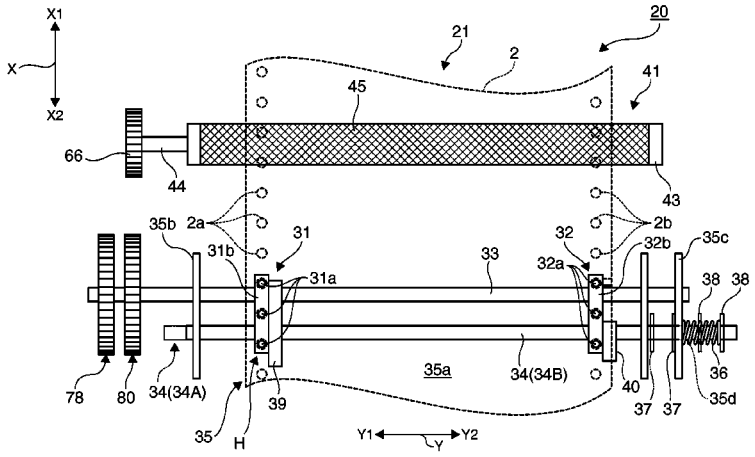
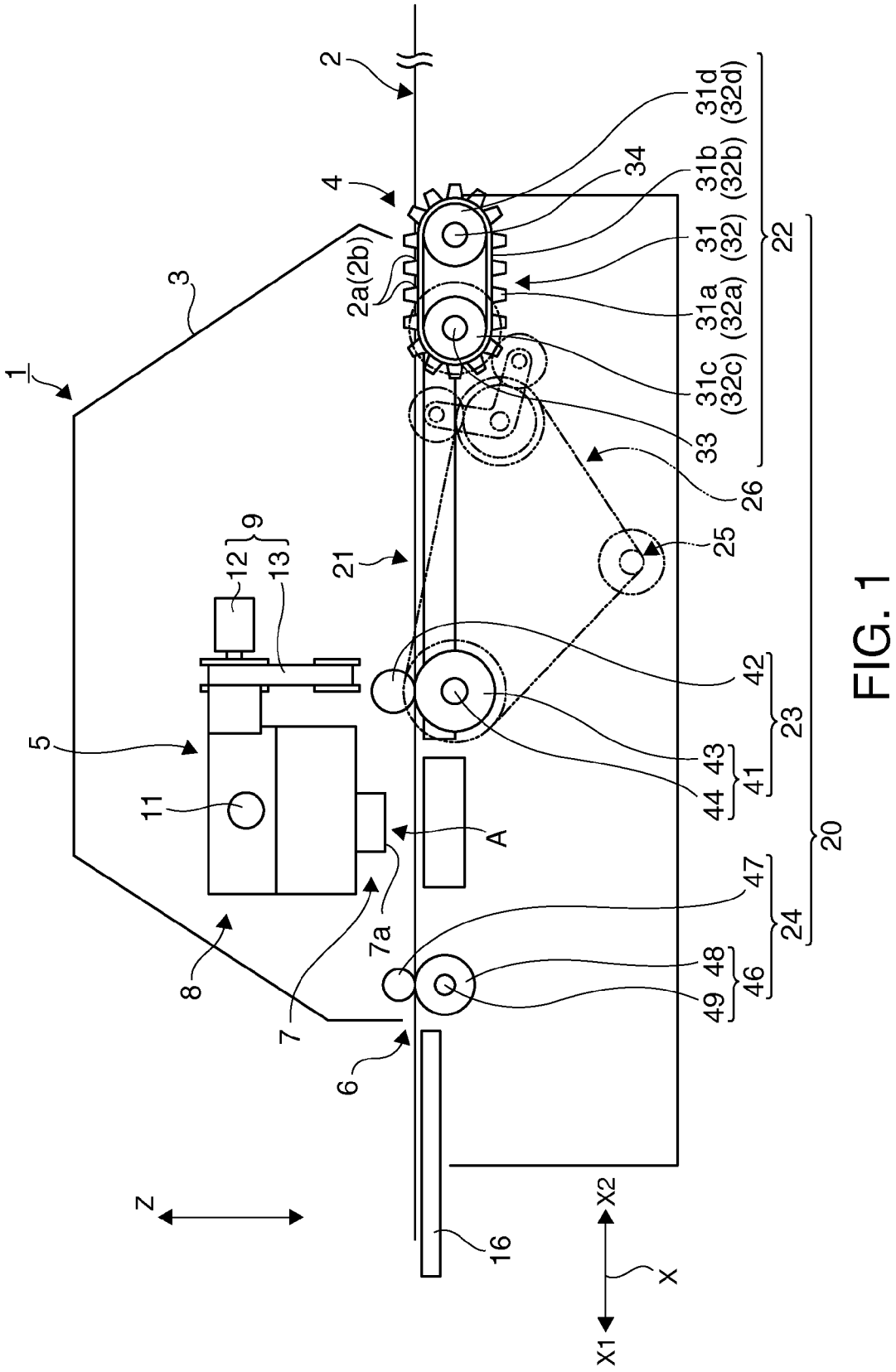
(57) **ABSTRACT**

A tractor unit has first and second tractors with tractor pins that engage sprocket holes on opposites sides of continuous paper. A tractor support shaft supports the tractors movably in the device width direction. A frame supports the tractor support shaft movably in the device width direction. A clamping mechanism is provided for fixing the second tractor on the tractor support shaft. The first tractor **31** is disposed at a reference position in the device width direction. A biasing member biases the tractor support shaft in a second direction when the tractor support shaft moves in a first direction opposite to the second direction.

5 Claims, 6 Drawing Sheets

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31
31a (32a)
31b (32b)
31c (32c)
31d (32d)
33
34
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44
46
47
48
49
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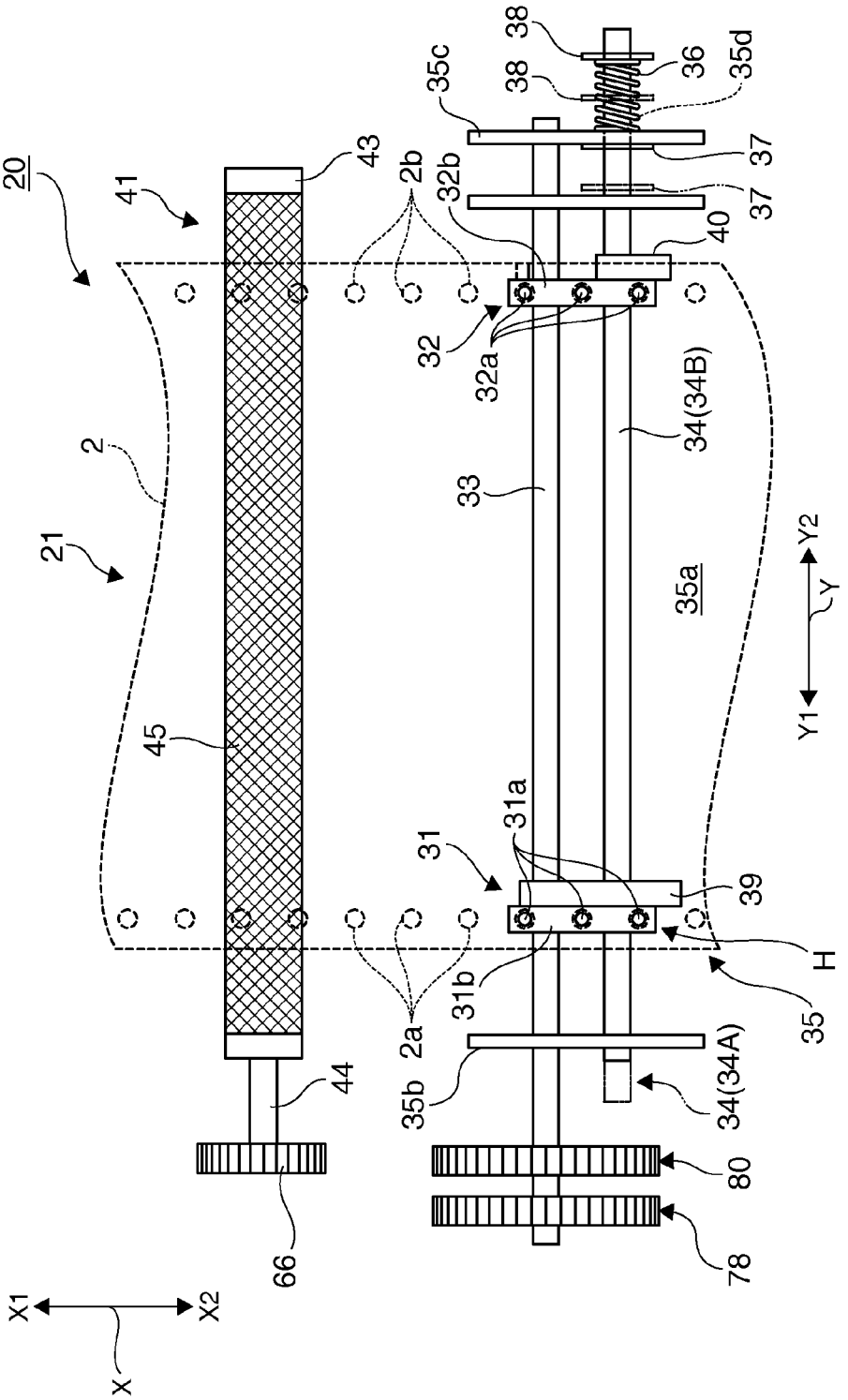
A
Z
X
X1
X2

FIG. 1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36
35d
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33
21
35a
Y2
Y
Y1
45
31a
31
39
H
31b
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2a
35b
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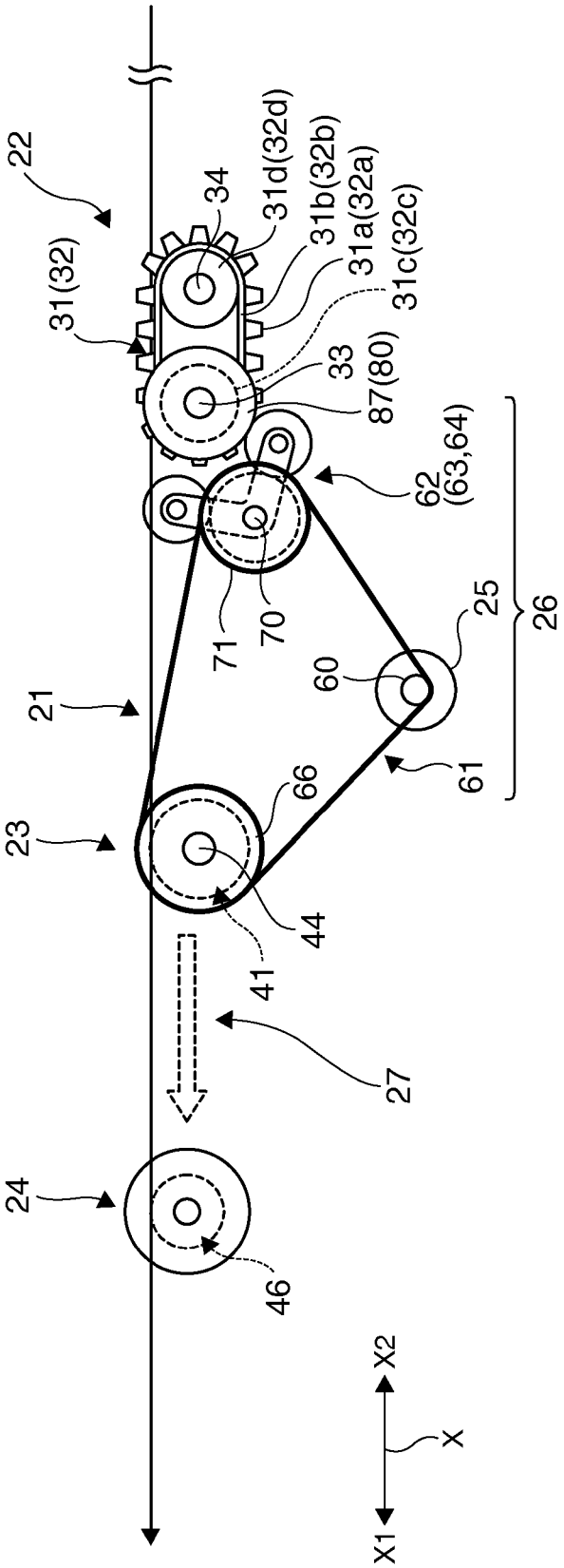
80
66
78
X1
X2
X

FIG. 2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31(32)
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31b(32b)
31a(32a)
31c(32c)
33
87(80)
62
(63,64)
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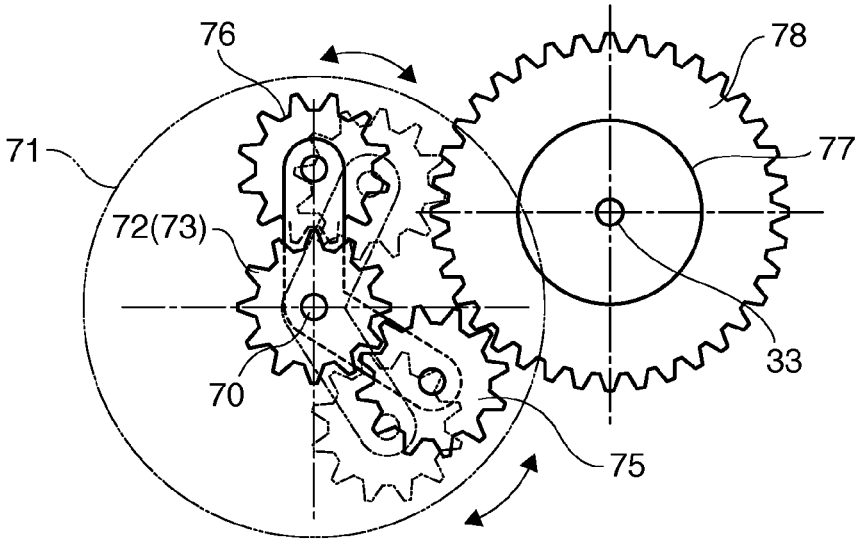
41
27
24
46
X2
X
X1

FIG. 3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33
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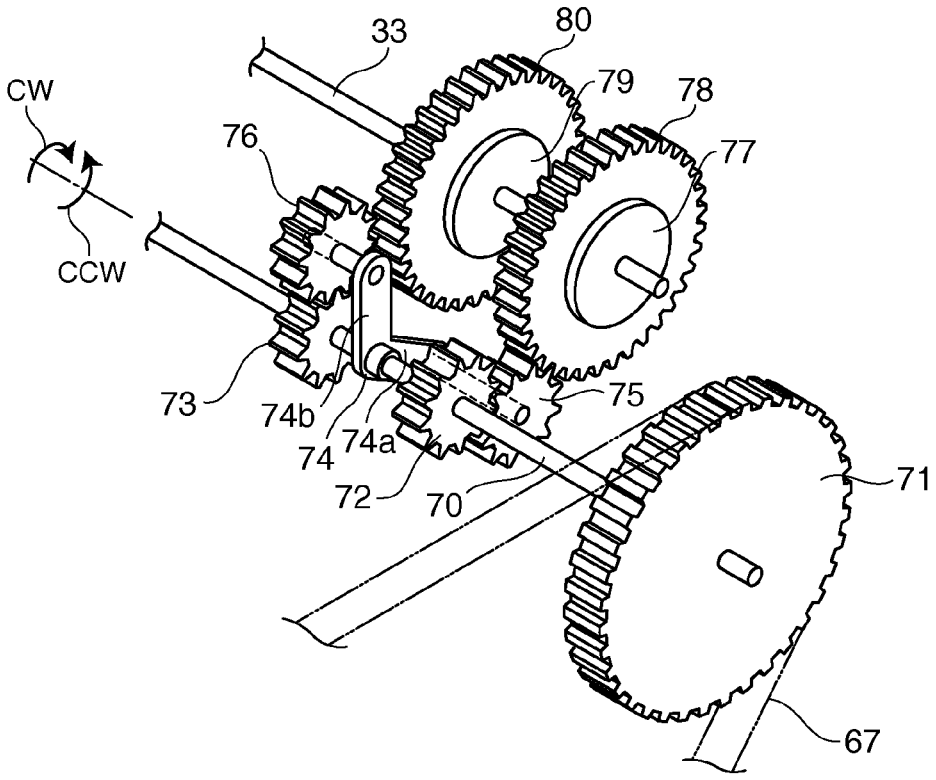
75

FIG. 4A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80
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78
76
77
CCW
73
74b
74a
74
72
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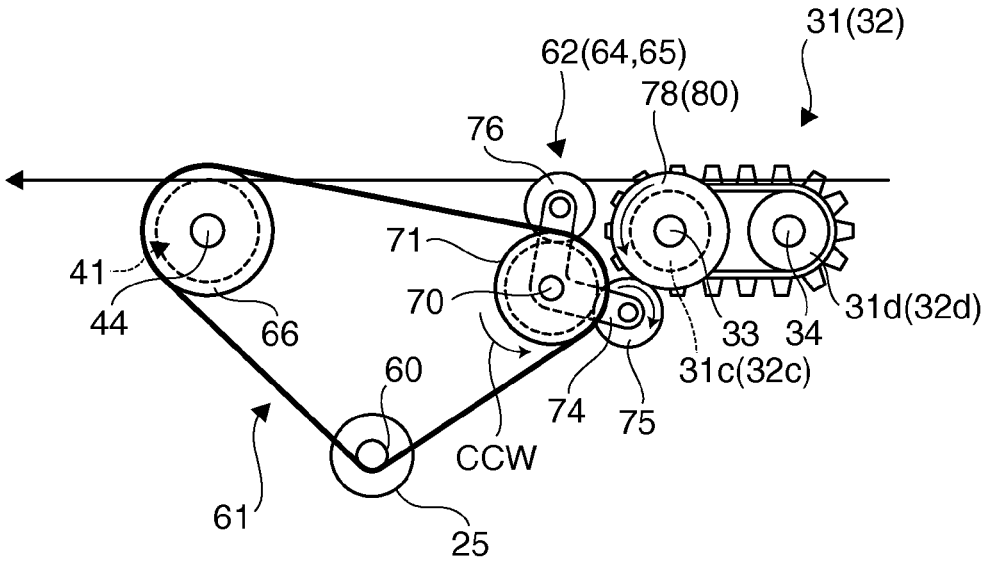
75
71
67

FIG. 4B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76
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41
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74
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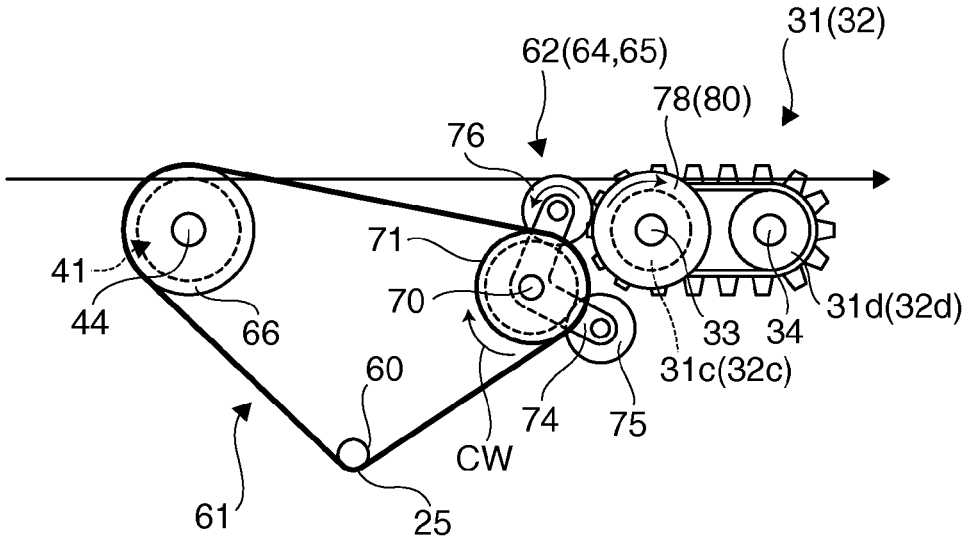
31c(32c)
33
34
31d(32d)
CCW
61
25

FIG. 5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78(80)
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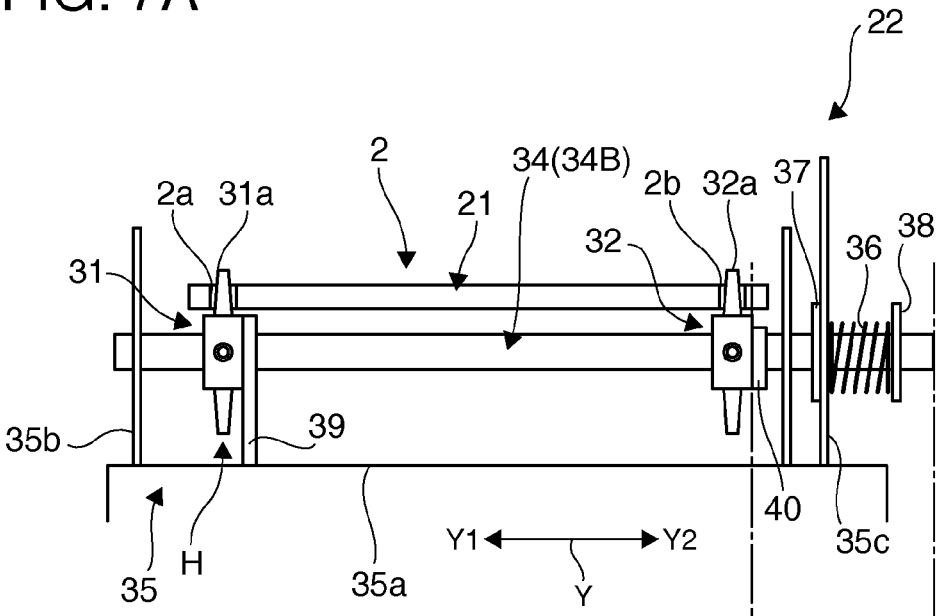
31d(32d)
CW
61
25

FIG. 6

FIG. 7A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2
34(34B)
2a
31a
21
2b
32a
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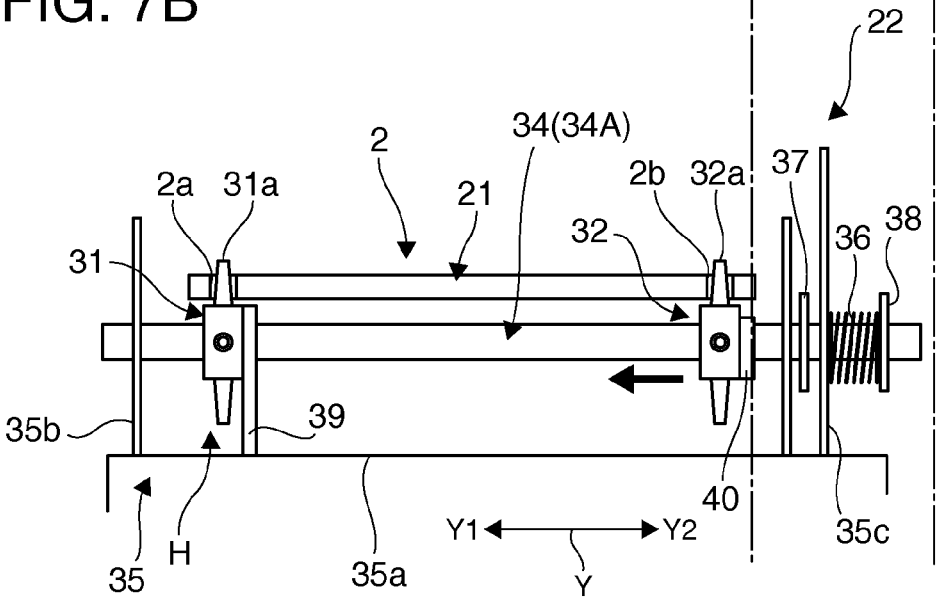
38
31
32
36
35b
39
40
35c
H
35
35a
Y1
Y2
Y

FIG. 7B


22
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34(34A)
2a
31a
21
2b
32a
37
38
31
32
36
35b
39
40
35c
H
35
35a
Y1
Y2
Y

TRACTOR UNIT, CONVEYANCE DEVICE, AND PRINTER

RELATED APPLICATION(S)

The instant invention is a continuation of U.S. patent application Ser. No. 13/939,473 filed Jul. 11, 2013 and claims priority to Japanese patent application No. 2012-173752 filed Aug. 6, 2012, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

1. Technical Field

The present disclosure relates to a tractor unit for conveying fanfold paper or other continuous paper having sprocket holes, to a conveyance device including the tractor unit, and to a printer having the conveyance device.

2. Related Art

Japanese Unexamined Patent Appl. Pub. JP-A-2006-8265 describes a conveyance device for conveying continuous paper. The conveyance device disclosed in JP-A-2006-8265 has a paper feed roller, and a tractor unit disposed on the upstream side of the paper feed roller in the conveyance direction of the continuous paper. The tractor unit in JP-A-2006-8265 has a first tractor, a second tractor, a support shaft, and a clamping mechanism. The first tractor has first tractor pins that can engage first sprocket holes formed along one side in the width direction of the continuous paper. The second tractor has second tractor pins that can engage second sprocket holes formed along the other side in the width direction of the continuous paper. The support shaft supports the first tractor and second tractor so that both tractors can move in a transverse direction perpendicular to the conveyance direction of the continuous paper. The clamping mechanism holds the second tractor in a fixed position on the support shaft.

Continuous paper is set in the conveyance device described in JP-A-2006-8265 by engaging the first sprocket holes in the continuous paper with the tractor pins of the first tractor set to a reference position, then sliding the second tractor along the support shaft to a position appropriate to the width of the continuous paper and engaging the second sprocket holes of the continuous paper on the tractor pins of the second tractor, and then clamping the second tractor to the support shaft.

The conveyance device described in JP-A-2006-8265 conveys continuous paper that has already been printed on by an electrophotographic printer. When continuous paper is printed on using an electrophotographic process, the continuous paper may shrink widthwise due to the heat used to fuse the toner image formed on a photoconductive element to the continuous paper. Because the distance between the sprocket holes formed on one side of the continuous paper and the sprocket holes formed on the other side changes when the continuous paper shrinks widthwise, the sprocket holes of the continuous paper sometimes separate from the tractor pins of the first tractor or the tractor pins of the second tractor while the continuous paper is conveyed.

To prevent this, the tractor unit disclosed in JP-A-2006-8265 has a stop affixed to a position corresponding to the reference position on the support shaft, and disposes the first tractor to the reference position by pushing the first tractor towards the stop and away from the second tractor using a spring member so that the first tractor contacts the stop. When the width of the continuous paper shrinks, the first tractor moves toward the second tractor in resistance to the spring member and reduces the gap between the first tractor and the second tractor. The tractor unit can therefore prevent sprocket holes in the continuous paper from disengaging the tractor pins.

Separation of the sprocket holes from the tractor pins while the continuous paper is conveyed by a paper feed device using a tractor unit is not limited to when the width of the continuous paper shrinks as a result of the printing method. For example, when the conveyance direction of the continuous paper by the paper feed roller and the conveyance direction of the continuous paper by the tractor unit do not match precisely due to the dimensional precision of the paper feed roller and parts of the tractor unit, or the installation precision of the paper feed roller and tractor unit in the printer, the continuous paper may travel in a direction intersecting the conveyance direction due to the conveyance force of the paper feed roller, causing the sprocket holes to separate from the tractor pins. Using the tractor unit disclosed in JP-A-2006-8265 to avoid this is possible.

However, the inventor(s) has noted that when the continuous paper is set in the tractor unit disclosed in JP-A-2006-8265, the user may apply too much tension across the width of the continuous paper. More specifically, the continuous paper becomes easily skewed as it is pulled downstream by the conveyance force of the paper feed roller if there is slack across the width of the continuous paper between the first tractor and the second tractor when the continuous paper is set in the tractor unit. As a result, after engaging the tractor pins of the second tractor with the sprocket holes of the continuous paper, the user commonly pulls the second tractor in the direction away from the first tractor and applies tension across the width so that there is no slack in the continuous paper, and then clamps the second tractor to the support shaft.

If the user pulls the second tractor with such force that the first tractor moves toward the second tractor when pulling the second tractor away from the first tractor, tension will be applied to the continuous paper by both the excess tension applied by the user and the urging force of the spring member, and the second tractor will be clamped to the support shaft with excessive tension on the paper. However, the continuous paper conversely separates from the sprocket holes more easily if the continuous paper moves in a direction intersecting the conveyance direction when excessive tension is applied across the width of the continuous paper by the pair of tractors.

SUMMARY

In some embodiments, a tractor unit comprises first and second tractors, a support shaft, a frame, a biasing member and a clamping member. The first tractor has first tractor pins configured to be engaged in first sprocket holes formed in continuous paper to be conveyed in the paper conveyance direction along a first side of the continuous paper. The second tractor has second tractor pins configured to be engaged in second sprocket holes formed in the continuous paper along a second side of the continuous paper. The second side is opposite the first side across a paper width of the continuous paper. The support shaft extends in a transverse direction perpendicular to the conveyance direction of the continuous paper, and supports the first tractor and second tractor movably in the transverse direction. The frame supports the support shaft movably in the transverse direction. The biasing member is configured to bias the support shaft in the transverse direction. The clamping member is configured to fix the second tractor on the support

shaft. The first tractor is disposed at a predetermined reference position in the transverse direction. The biasing member is configured to bias the support shaft in a second direction opposite a first direction, when the support shaft moves in the first direction oriented from the second tractor toward the first tractor.

In some embodiments, a conveyance device includes the tractor unit described above, a conveyance roller, and a drive source. The conveyance roller is disposed parallel to the support shaft and downstream of the tractor unit in the conveyance direction. The drive source is configured to rotationally drive the conveyance roller.

In some embodiments, a printing device includes the conveyance device described above, and a print unit that is disposed downstream in the conveyance direction from the conveyance device. The print unit is configured to print on the continuous paper conveyed by the conveyance device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of an inkjet printer according to at least of one embodiment of the invention.

FIG. **2** is a plan view showing a conveyance device in the inkjet printer.

FIG. **3** is a side view showing a power transfer mechanism in the conveyance device.

FIG. **4**A is a side view showing a tractor-side drive power transfer mechanism in the conveyance device.

FIG. **4**B is a perspective view showing the tractor-side drive power transfer mechanism.

FIG. **5** is a schematic side view showing a roller-side drive power transfer mechanism and a forward rotation transfer mechanism in the conveyance device.

FIG. **6** is a schematic side view showing the roller-side drive power transfer mechanism and a reverse rotation transfer mechanism in the conveyance device.

FIG. **7**A is a front view that shows a second tractor just before being clamped to a tractor support shaft in the conveyance device.

FIG. **7**B is a view similar to FIG. **7**A showing the second tractor clamped to the tractor support shaft.

DESCRIPTION OF EMBODIMENTS

At least of one embodiment of the present invention is described below with reference to the accompanying figures. In the accompanying figures, arrow X indicates the conveyance direction of the continuous paper through the conveyance path, arrow X**1** indicating forward (normal paper feed direction) and arrow X**2** indicating reverse in the conveyance direction X. Arrow Y indicates the device width direction (transverse direction) Y perpendicular to the conveyance direction, arrow Y**1** indicating a first direction Y**1** from a second tractor to a first tractor of the tractor unit in the device width direction Y, and arrow Y**2** indicating a second direction Y**2** from the first tractor to the second tractor of the tractor unit in the device width direction Y.

General Configuration

FIG. **1** is a side view that shows the overall configuration of an inkjet printer according to at least one embodiment of the invention. FIG. **2** is a plan view showing a conveyance device of the inkjet printer.

The inkjet printer (printing device) **1** pulls continuous paper **2** through the supply opening **4** disposed in the back of the printer case **3**, prints on the continuous paper **2** with the print unit **5**, and discharges the continuous paper **2** from a paper exit **6** disposed in the front of the printer case **3**. The continuous paper **2** is, for example, fanfold paper, and has first sprocket holes **2***a* and second sprocket holes **2***b* formed at a uniform pitch along the length of the continuous paper **2** , and on both sides of the continuous paper **2** in the paper width direction as shown in FIG. **2**.

The print unit **5** includes a printhead **7**, carriage **8**, and carriage moving mechanism **9**. The printhead **7** has a plurality of nozzles **7***a* that eject ink droplets onto the continuous paper **2**. The printhead **7** is carried on the carriage **8** with the nozzles **7***a* facing down on the z-axis shown in FIG. **1**, that is, facing the continuous paper **2**.

The carriage **8** is supported movably along a carriage shaft **11** that extends in the device width direction Y, and is moved bidirectionally in the device width direction Y by the carriage moving mechanism **9**. The carriage moving mechanism **9** includes a carriage motor **12** and a timing belt **13** driven by the carriage motor **12**. The carriage **8** is affixed to the timing belt **13**, and is moved bidirectionally in the device width direction Y according to the operation of the carriage motor **12**.

The inkjet printer **1** also has a conveyance device **20** that conveys the continuous paper **2**. FIG. **3** is a side view of the conveyance device **20**.

As shown in FIG. **1**, the conveyance device **20** includes a conveyance path **21**, tractor unit **22**, first conveyance mechanism **23**, and second conveyance mechanism **24**. As shown in FIG. **3**, the conveyance device **20** also has a conveyance motor **25** that drives the tractor unit **22**, first conveyance mechanism **23**, and second conveyance mechanism **24**; a drive power transfer mechanism **26** that transfers rotational drive power from the conveyance motor **25** to the tractor unit **22** and first conveyance mechanism **23**; and a drive power transfer wheel train **27** that transfers the rotational drive power transferred to the first conveyance mechanism **23** from the conveyance motor **25** to the second conveyance mechanism **24**.

The conveyance path **21** extends in the direction of arrow X in FIG. **1**, starting from the supply opening **4**, passing the printing position A of the printhead **7** of the print unit **5**, and ending at the paper exit **6**. The tractor unit **22**, first conveyance mechanism **23**, print unit **5**, and second conveyance mechanism **24** are disposed in this order along the conveyance path **21** from the supply opening **4** side to the paper exit **6** side.

Tractor Unit

The tractor unit **22** is disposed near the supply opening **4**. As shown in FIG. **2**, the tractor unit **22** includes a first tractor **31** and a second tractor **32** that hold the continuous paper **2** on opposite sides of the paper width; a tractor drive shaft **33** (drive shaft) and a tractor support shaft **34** (support shaft) supporting the first tractor **31** and second tractor **32** movably in the device width direction Y; a frame **35** that supports the tractor drive shaft **33** and tractor support shaft **34**; and a coil spring **36** (biasing or elastic member) that can bias or apply an urging force (pressure) urging (pushing) the tractor support shaft **34** in the device width direction Y of the continuous paper **2**. The tractor drive shaft **33** and tractor support shaft **34** extend parallel to each other in the device width direction Y. The tractor drive shaft **33** is on the side of the tractor support shaft **34** closer to the first conveyance mechanism **23**, or more specifically is downstream of the tractor support shaft **34** in the conveyance direction.

As shown in FIG. **1** and FIG. **2**, the first tractor **31** includes a first tractor belt **31***b* (first endless belt) with multiple first tractor pins **31***a* disposed on the outside surface, and a first drive pulley **31***c* and first follower pulley **31***d* on which the first tractor belt **31***b* is mounted.

The second tractor **32** includes a second tractor belt **32***b* (second endless belt) with multiple second tractor pins **32***a* disposed on the outside surface, and a second drive pulley **32***c* and second follower pulley **32***d* on which the second tractor belt **32***b* is mounted.

The first drive pulley **31***c* and second drive pulley **32***c* are supported coaxially by the tractor drive shaft **33** and rotate in unison with the tractor drive shaft **33**. The first follower pulley **31***d* and second follower pulley **32***d* are supported coaxially and rotate freely on the tractor support shaft **34**.

The first tractor pins **31***a* can engage the first sprocket holes **2***a* on one side of the continuous paper **2** width, and the second tractor pins **32***a* can engage the second sprocket holes **2***b* on the other side of the continuous paper **2** width. The first tractor **31** and second tractor **32** also have a tractor cover (not shown in the figure) that partially covers the part holding the continuous paper **2** after the continuous paper **2** is set and held with the sprocket holes **2***a* and **2***b* engaged on the respective tractor pins **31***a*, **32***a*.

The frame **35** includes a main frame portion **35***a* extending in the device width direction Y below the tractor drive shaft **33** and tractor support shaft **34**, and a first support panel **35***b* and second support panel **35***c* on opposite sides of the device width direction Y with the conveyance path **21** therebetween.

The first support panel **35***b* supports the first direction Y**1** ends of the tractor drive shaft **33** and tractor support shaft **34** (that is, the ends on the first tractor **31** side), and the second support panel **35***c* supports the second direction Y**2** ends of the tractor drive shaft **33** and tractor support shaft **34** (that is, the ends on the second tractor **32** side).

The tractor drive shaft **33** can rotate on its axis supported by the first support panel **35***b* and second support panel **35***c*. The tractor support shaft **34** is supported movably in the device width direction Y by the first and second support panels.

A bearing hole **35***d* for supporting the tractor support shaft **34** is disposed in the second support panel **35***c*. The second direction Y**2** end of the tractor support shaft **34** passes through the bearing hole **35***d* and is supported by the second support panel **35***c*. A support shaft stop **37** that limits the range of support shaft movement is arranged on the tractor support shaft **34** at a specific distance in the first direction Y**1** from the second tractor **32** side end. The support shaft stop **37** is disposed on the inside side (the conveyance path **21** side) of the second support panel **35***c*.

A coil spring **36** that expands and contracts in the device width direction Y is disposed around the outside of the end of the tractor support shaft **34** protruding to the outside (the opposite side as the conveyance path **21**) from the second support panel **35***c*. The coil spring **36** is disposed at a position near the outside of the second support panel **35***c* with one end in the spring axis direction connected to the second support panel **35***c*, and the other end connected to the tractor support shaft **34**. This other end of the coil spring **36** and the tractor support shaft **34** are connected through an E-ring **38** fixed on the tractor support shaft **34**. One of the first and second tractors (e.g., the second tractor **32**) is disposed between the coil spring **36** and the other tractor (e.g., the first tractor **31**). In the embodiment specifically shown in FIG. **2**, the coil spring **36** is separated from the conveyance path **21** by the second support panel **35***c*.

The tractor support shaft **34** can move between a first position **34**A and a second position **34**B that are displaced from each other in the device width direction Y. The second position **34**B indicated by a solid line in FIG. **2** is the position at which the coil spring **36** supports the tractor support shaft **34** in the initial position when continuous paper **2** is not set in the tractor unit **22**.

When the tractor support shaft **34** is held in the second position **34**B, the coil spring **36** is at its natural length without biasing the tractor support shaft **34**, and the support shaft stop **37** is in contact with the second support panel **35***c*. When the tractor support shaft **34** moves in the first direction Y**1**, the coil spring **36** exerts an urging force urging the tractor support shaft **34** in the second direction Y**2**, that is, opposite the first direction Y**1**.

The first position **34**A is a position displaced in the first direction Y**1** from the second position **34**B, and is denoted by the imaginary double-dot dash line in FIG. **2**. The first position **34**A is where the tractor support shaft **34** is located when the coil spring **36** is fully compressed.

The tractor unit **22** includes a positioning stop **39** that positions the first tractor **31** at a predetermined reference position H in the device width direction Y, and a clamping mechanism **40** that clamps the second tractor **32** to the tractor support shaft **34**.

The positioning stop **39** is a flat member that protrudes up from the main frame portion **35***a*, and has a through-hole in which the tractor drive shaft **33** is inserted and rotates, and a through-hole in which the tractor support shaft **34** is inserted and can move in the device width direction. The first tractor **31** is attached to the first direction Y**1** side surface of the positioning stop **39**, and thereby set to the reference position H. The first tractor **31** is still moveable relative to the tractor support shaft **34** in the device width direction Y.

The clamping mechanism **40**, in at least one embodiment, is mounted on the second tractor **32**. The clamping mechanism **40** includes, for example, a plastic member that can move between a clamping position pressed against the tractor support shaft **34** and an open position separated from the tractor support shaft **34**, and a lever that sets the plastic member to the clamping position or the open position. The clamping mechanism **40** clamps the second tractor **32** to the tractor support shaft **34** when the lever is operated to move the plastic member from the open position to the clamping position. When the second tractor **32** is clamped to the tractor support shaft **34** by the clamping mechanism **40**, the second tractor **32** is disposed perpendicularly to the axis of the tractor drive shaft **33** and the axis of the tractor support shaft **34**, and the plural second tractor pins **32***a* are aligned with the conveyance direction X. When the second tractor **32** is clamped to the tractor support shaft **34** by the clamping mechanism **40**, the second tractor **32** can also move in the device width direction Y in unison with the tractor support shaft **34**.

First Conveyance Mechanism

The first conveyance mechanism **23** is disposed between the tractor unit **22** and the printing position A on the conveyance path **21**, and more specifically close to the printhead **7**. The first conveyance mechanism **23** includes a paper feed roller **41** and a pressure roller **42**. The paper feed roller **41** includes a metal roller **43** and a roller shaft **44**, and is disposed transverse to the conveyance path **21** at a position below the conveyance path **21** on the z-axis. The pressure roller **42** is rubber or other elastic material, and is configured to press the continuous paper **2** conveyed through the conveyance path **21** against the paper feed roller **41** from above on the z-axis.

As shown in FIG. **2**, the surface of the roller **43** has a friction coating **45** formed by a dispersion of inorganic particles. The friction coating **45** is formed by dispersing inorganic particles of aluminum oxide (alumina, Al2O3), silicon monoxide (SiO), or silicon dioxide (SiO2), for

example, in a layer of polyester resin. At least one embodiment uses crushed alumina as the inorganic particles. Alumina is relative inexpensive and does not interfere with reducing cost, is relatively hard, and desirably improves friction resistance. The crushing process also produces alumina particles with sharp corners, resulting in high friction force.

Second Conveyance Mechanism

The second conveyance mechanism **24** is disposed between the printing position A on the conveyance path **21** and the paper exit **6**, and more specifically near the printhead **7**. The second conveyance mechanism **24** includes a discharge roller **46** and a pressure roller **47**. The discharge roller **46** includes a roller **48** and a roller shaft **49**, and is disposed transverse to the conveyance path **21** at a position below the conveyance path **21** on the z-axis. The pressure roller **47** is configured to press the continuous paper **2** conveyed through the conveyance path **21** against the discharge roller **46** from above on the z-axis.

Drive power transfer mechanism and drive power transfer wheel train

As shown in FIG. **3**, the drive power transfer mechanism **26** has a roller-side drive power transfer mechanism **61** and a tractor-side drive power transfer mechanism **62**.

The roller-side drive power transfer mechanism **61** transfers forward rotation for conveying the continuous paper **2** forward (in the direction of arrow X**1**) through the conveyance path **21**, and reverse rotation for conveying the paper in reverse (the direction of arrow X**2**), from the conveyance motor **25** to the paper feed roller **41** of the first conveyance mechanism **23**.

The tractor-side drive power transfer mechanism **62** transfers rotation from the conveyance motor **25** to the tractor drive shaft **33** of the tractor unit **22**.

The drive power transfer wheel train **27** causes the discharge roller **46** of the second conveyance mechanism **24** to turn synchronously to the paper feed roller **41** of the first conveyance mechanism **23** at the same conveyance speed in the same direction. The drive power transfer wheel train **27** is denoted by a dotted line in FIG. **3**.

The tractor-side drive power transfer mechanism **62** includes a forward transfer mechanism **63** and a reverse transfer mechanism **64**. As described below with reference to FIG. **4**A and FIG. **4**B, the forward transfer mechanism **63** transfers forward rotation from the conveyance motor **25** through a one-way clutch **77** to the tractor unit **22**, and the reverse transfer mechanism **64** transfers reverse rotation from the conveyance motor **25** through a torque limiter **79** (torque clutch) to the tractor unit **22**.

When conveying the continuous paper **2** forward in at least one embodiment, the conveyance speed of the continuous paper **2** conveyed by the paper feed roller **41** driven through the roller-side drive power transfer mechanism **61** is greater than the conveyance speed of the continuous paper **2** conveyed by the first tractor **31** driven through the forward transfer mechanism **63**. The speed reduction ratios of the wheel trains in the transfer mechanisms are set to achieve this relationship.

Conversely, when conveying the paper in reverse, the conveyance speed of the continuous paper **2** conveyed by the first tractor **31** driven through the reverse transfer mechanism **64** is greater than the conveyance speed of the continuous paper **2** conveyed by the paper feed roller **41** through the roller-side drive power transfer mechanism **61**. The speed reduction ratios of the wheel trains in the transfer mechanisms are set to achieve this relationship.

The roller-side drive power transfer mechanism **61** includes a drive sprocket **60** fixed coaxially to the output shaft of the conveyance motor **25**, a drive gear **66** fixed coaxially to the end part of the roller shaft **44** of the paper feed roller **41** in the first conveyance mechanism **23**, and a timing belt **67** mounted on the drive sprocket **60** and drive gear **66**.

FIG. **4**A is a side view showing the tractor-side drive power transfer mechanism **62**, and FIG. **4**B is a perspective view of the same. The configuration of the tractor-side drive power transfer mechanism **62** that transfers power driving rotation of the tractor unit **22** forward and reverse is described next with reference to FIG. **3**, FIG. **4**A, and FIG. **4**B.

The tractor-side drive power transfer mechanism **62** has a rotating shaft **70**, a transfer gear **71** is fixed coaxially to the rotating shaft **70**, and the timing belt **67** is mounted on the transfer gear **71**. A forward sun gear **72** and a reverse sun gear **73** are fixed coaxially on the rotating shaft **70**. A planetary carrier **74** is supported freely pivotably on the rotating shaft **70** between the sun gears **72**, **73**.

The planetary carrier **74** has two arms **74***a*, **74***b* extending radially with a specific angle therebetween from the rotating shaft **70**. A forward planetary gear **75** is supported freely rotationally on the end part of the one arm **74***a*. The forward planetary gear **75** meshes with the forward sun gear **72**. A reverse planetary gear **76** is supported freely rotationally on the end part of the other arm **74***b*. The reverse planetary gear **76** meshes with the reverse sun gear **73**.

A forward transfer gear **78** is coaxially attached through the one-way clutch **77** to the end part of the tractor drive shaft **33**. The one-way clutch **77** could be either a sprag or cam clutch. The one-way clutch **77** transfers forward rotation, but turns freely and interrupts transfer of reverse rotation when reverse rotation for feeding the paper in reverse is received. The one-way clutch **77** therefore turns freely and the power transfer path is also interrupted while transferring forward rotation if a transfer member downstream of the one-way clutch **77** on the transfer path tries to turn faster in the forward rotation direction than the transfer member on the upstream side of the transfer path. When the one-way clutch **77** rotates freely, that is, when the transfer path is interrupted, the first tractor **31** and second tractor **32** follow the movement of the continuous paper **2** conveyed through the conveyance path **21** by the paper feed roller **41**.

The forward transfer gear **78** is a gear that can mesh with the forward planetary gear **75**, and is disposed at a position opposite the forward planetary gear **75**. A reverse transfer gear **80** is disposed beside the forward transfer gear **78**. The reverse transfer gear **80** is affixed coaxially to the end of the tractor drive shaft **33** through the torque limiter **79**. The reverse transfer gear **80** is a gear that can mesh with the reverse planetary gear **76**, and is disposed at a position opposite the reverse planetary gear **76**. The torque limiter **79** slips when the transferred torque exceeds a specific limit, and limits transferring torque exceeding the limit.

In the tractor-side drive power transfer mechanism **62** thus comprised, the forward transfer mechanism **63** is the part of the transfer mechanism that sequentially transfers rotation from the timing belt **67** through the rotating shaft **70**, forward sun gear **72**, planetary carrier **74**, forward planetary gear **75**, forward transfer gear **78**, and one-way clutch **77** to the tractor drive shaft **33**. The reverse transfer mechanism **64** is the part that sequentially transfers rotation from the timing belt **67** through the rotating shaft **70**, reverse

sun gear **73**, planetary carrier **74**, reverse planetary gear **76**, reverse transfer gear **80**, and torque limiter **79** to the tractor drive shaft **33**.

FIG. **5** is a side view showing the roller-side drive power transfer mechanism **61** and forward transfer mechanism **63**. FIG. **6** is a side view showing the roller-side drive power transfer mechanism **61** and reverse transfer mechanism **64**.

When transferring forward rotation, the rotating shaft **70** turns counterclockwise as indicated by arrow CCW in FIG. **4**B. This rotation causes the planetary carrier **74** to also turn in the same direction. As a result, the forward planetary gear **75** meshes with the forward transfer gear **78**. The other reverse planetary gear **76** disengages the reverse transfer gear **80**. As a result, the tractor-side drive power transfer mechanism **62** is positioned as shown in FIG. **5**.

In this position, forward rotation from the conveyance motor **25** is transferred through the roller-side drive power transfer mechanism **61** to the paper feed roller **41** and discharge roller **46**. The forward rotation is also transferred through the tractor-side drive power transfer mechanism **62** to the first tractor **31** and second tractor **32**. The continuous paper **2** is therefore fed forward.

When transferring reverse rotation, the rotating shaft **70** turns clockwise as indicated by arrow CW in FIG. **4**B. This rotation causes the planetary carrier **74** to also turn in the same direction. As a result, the forward planetary gear **75** separates from and disengages with the forward transfer gear **78** (the drive power transfer path is interrupted). The other reverse planetary gear **76** approaches and engages the reverse transfer gear **80** (completing the drive power transfer path) . As a result, the tractor-side drive power transfer mechanism **62** is positioned as shown in FIG. **6**.

In this position, reverse rotation from the conveyance motor **25** is transferred through the roller-side drive power transfer mechanism **61** to the paper feed roller **41** and discharge roller **46**. The reverse rotation is also transferred through the tractor-side drive power transfer mechanism **62** to the first tractor **31** and second tractor **32**. The continuous paper **2** is therefore fed in reverse (reversed).

Continuous Paper Conveyance Operation

Operation of the inkjet printer **1**, and particularly the continuous paper **2** conveyance operation of the conveyance device **20**, is described next. FIG. **7**A and FIG. **7**B describe setting the continuous paper **2** in the tractor unit **22**, and show the tractor unit **22** from the back in the conveyance direction X. FIG. **7**A shows a state immediately before clamping the second tractor **32** to the tractor support shaft **34**, and FIG. **7**B shows a state after the second tractor **32** is clamped to the tractor support shaft **34**.

To set the continuous paper **2** in the tractor unit **22**, the first sprocket holes **2***a* on one side of the continuous paper **2** width are placed on the first tractor pins **31***a* of the first tractor **31** disposed at the reference position H in the transverse direction. Next, the second tractor **32** is slid to a position on the tractor support shaft **34** matching the width of the continuous paper **2**, and the second tractor pins **32***a* of the second tractor **32** are engaged with the second sprocket holes **2***b* on the other side of the continuous paper **2** width. When the second tractor pins **32***a* of the second tractor **32** have engaged the second sprocket holes **2***b* in the continuous paper **2**, the tractor support shaft **34** is held at the second position **34**B by the coil spring **36** as shown in FIG. **7**A. The second tractor **32** is then clamped to the tractor support shaft **34** by the clamping mechanism **40**.

If there is slack in the continuous paper **2** between the first tractor **31** and second tractor **32** when the continuous paper **2** is set in the tractor unit **22**, it is possible that the continuous paper **2** becomes skewed when the continuous paper **2** is pulled downstream by the conveyance force of the paper feed roller **41**. To avoid or suppress skewing, the user pulls the second tractor **32** away from the first tractor **31** to apply tension to the width of the continuous paper **2** after engaging the second sprocket holes **2***b* of the continuous paper **2** on the tractor pins of the second tractor **32**, and then clamps the second tractor **32** to the tractor support shaft **34**. However, if the user clamps the second tractor **32** to the tractor support shaft **34** while applying strong tension to the continuous paper **2**, the continuous paper **2** may be held with too much tension. When this happens, it is possible that the sprocket holes in the continuous paper **2** disengage the first tractor pins **31***a* or second tractor pins **32***a* if the continuous paper **2** moves in a direction intersecting the conveyance direction X while the continuous paper **2** is conveyed.

To address this potential problem, when excess tension is applied to the continuous paper **2** when the second tractor **32** is clamped to the tractor support shaft **34** in at least one embodiment, the second tractor **32** moves with the tractor support shaft **34** in the first direction Y**1** (the direction in which the coil spring **36** stretches) to a position where the urging force of the coil spring **36** and the tension on the continuous paper **2** are balanced (FIG. **7**B).

In other words, the spring constant of the coil spring **36** is set appropriately so that the second tractor **32** and tractor support shaft **34** move and the tractor support shaft **34** stops between the first position **34**A and second position **34**B. Because the excess tension on the continuous paper **2** is relieved by the second tractor **32** moving to a position where the urging force of the coil spring **36** and the continuous paper **2** tension are balanced, the sprocket holes in the continuous paper **2** will not easily separate from the first tractor pins **31***a* or second tractor pins **32***a* even if the continuous paper **2** moves in a direction intersecting the conveyance direction X while the continuous paper **2** is conveyed. Skewing of the continuous paper **2** can also be prevented because the tension across the width of the continuous paper **2** is appropriately maintained by the second tractor **32** being disposed where the urging force of the spring member and the tension on the continuous paper **2** are balanced.

The coil spring **36** in at least one embodiment (biases) exerts urging force on the tractor support shaft **34**, and does not (bias) exert urging force that directly urges the first tractor **31** or second tractor **32**. Therefore, when the user pulls the second tractor **32** away from the first tractor **31** after engaging the second tractor pins **32***a* with the second sprocket holes **2***b* in the continuous paper **2** when setting the continuous paper **2** in the tractor unit **22**, the urging force of the coil spring **36** does not work on the continuous paper **2** or the second tractor **32** that pulls the continuous paper **2**. The second tractor **32** can therefore move in the device width direction Y (direction Y**2**), and the continuous paper **2** can be easily loaded in the tractor unit **22**. In addition, when the user pulls the second tractor **32** away from the first tractor **31**, the first tractor **31** moves toward the second tractor **32** while compressing the coil spring **36**, and the second tractor **32** is not clamped to the tractor support shaft **34** with both the excess tension applied by the pulling force of the user and the urging force of the coil spring **36** applied to the continuous paper **2**.

The conveyance motor **25** then drives forward. As a result, the tractor-side drive power transfer mechanism **62** goes to the position shown in FIG. **5**, the first tractor **31** and paper feed roller **41** are rotationally driven forward, and the continuous paper **2** is conveyed through the conveyance path

21 toward the paper feed roller 41. The continuous paper 2 conveyed by the first tractor 31 is then nipped between the rotating paper feed roller 41 and pressure roller 42, and conveyed further to a specific indexing position (the start position of the printing operation).

When the continuous paper 2 is conveyed in the X1 direction, the forward conveyance speed of the paper feed roller 41 is greater than the forward conveyance speed of the first tractor 31. The paper holding force of the paper feed roller 41 is increased by the friction coating 45, but is lower than the paper holding force of the tractor 31 whereby the first tractor 31 engages the sprocket holes 2*a*. The continuous paper 2 is therefore conveyed while being pulled with constant tension from the paper feed roller 41 side. As a result, even when fanfold paper supplied from a stack of folded paper is used as the continuous paper 2, the paper can reach the indexing position with folds and slack appropriately removed.

The printhead 7 then prints while the paper feed roller 41 conveys the continuous paper 2 through the conveyance path 21. Because the coefficient of friction of the friction coating 45 is high, the continuous paper 2 is held by the paper feed roller 41 and pressure roller 42 with substantially no slipping, and the continuous paper 2 can be conveyed with high precision. The tractor 31 feeds the continuous paper 2 forward at a slower speed than the paper feed roller 41. The continuous paper 2 can therefore be constantly conveyed with specific tension applied thereto.

When the conveyance direction of the continuous paper 2 by the paper feed roller 41 and the conveyance direction of the continuous paper 2 by the tractor unit 22 do not precisely match due to the dimensional precision of the paper feed roller 41 and parts of the tractor unit 22, or the installation precision of the paper feed roller 41 and tractor unit 22 in the inkjet printer 1, the continuous paper 2 may travel in a direction intersecting the conveyance direction X due to the conveyance force of the paper feed roller 41, and the sprocket holes 2*a*, 2*b* can separate from the first tractor pins 31*a* or second tractor pins 32*a*.

To address this potential problem, the second tractor 32 holding the second direction Y2 edge part of the continuous paper 2 in at least one embodiment follows the movement of the continuous paper 2 and moves with the tractor support shaft 34 in the device width direction Y when the continuous paper 2 moves in the tractor unit 22 in a direction intersecting the conveyance direction X. The sprocket holes 2*a* and 2*b* of the continuous paper 2 can therefore be prevented from separating from the first tractor pins 31*a* or second tractor pins 32*a* while the continuous paper 2 is being conveyed.

When the continuous paper 2 is set in the tractor unit 22 in at least one embodiment, the second tractor 32 moves to a position where the urging force of the coil spring 36 and the tension on the continuous paper 2 are balanced as shown in FIG. 7B. As a result, the second tractor 32 and tractor support shaft 34 can move in both the first direction Y1 and second direction Y2 of the device width direction Y even though the urging force of the coil spring 36 is working on the tractor support shaft 34. The second tractor 32 therefore desirably follows movement of the continuous paper 2 in the device width direction Y. The sprocket holes 2*a* and 2*b* of the continuous paper 2 therefore do not easily separate from the first tractor pins 31*a* or second tractor pins 32*a*.

Furthermore, because the conveyance speed of the paper feed roller 41 is faster than the conveyance speed of the tractor unit 22, excess tension is applied by the conveyance force of the paper feed roller 41 while conveying the continuous paper 2, and it is possible that the sprocket holes 2*a* and 2*b* of the continuous paper 2 are separated from the first tractor pins 31*a* or second tractor pins 32*a* when the continuous paper 2 moves on the tractor unit 22 in the device width direction Y intersecting the conveyance direction X of the continuous paper 2.

By using a one-way clutch 77 in the tractor-side drive power transfer mechanism 62, at least one embodiment of the invention addresses this potential problem and prevents the conveyance force of the paper feed roller 41 from applying excess tension while conveying the continuous paper 2. More specifically, when the tension on the continuous paper 2 due to the conveyance force of the paper feed roller 41 exceeds a specific limit, the first tractor pins 31*a* of the first tractor 31 and the second tractor pins 32*a* of the second tractor 32 are forcibly pulled in the forward rotation direction by the paper feed roller 41, thus causing the one-way clutch 77 to turn freely and allow movement of the first tractor pins 31*a* and second tractor pins 32*a*. In other words, because the first tractor 31 and the second tractor 32 can simply follow movement of the continuous paper 2, the tension on the continuous paper 2 does not increase. The sprocket holes 2*a* and 2*b* of the continuous paper 2 can be prevented from easily separating from the first tractor pins 31*a* or second tractor pins 32*a* during paper conveyance. High print quality can also be achieved because the one-way clutch enables conveying the continuous paper 2 forward in a consistent, desirably tensioned state.

The continuous paper 2 conveyed by the paper feed roller 41 passes the printing position A of the print unit 5 and is printed on by the printhead 7. The continuous paper 2 then passes between the rotating discharge roller 46 and pressure roller 47. The continuous paper 2 is then further conveyed through the conveyance path 21 by the discharge roller 46, and discharged from the paper exit 6 into the discharge tray 16.

When the continuous paper 2 is to be conveyed in the reverse direction, the conveyance motor 25 is driven in the reverse rotation direction. This reverse rotation is transferred through the roller-side drive power transfer mechanism 61 to the paper feed roller 41, and through the tractor-side drive power transfer mechanism 62 to the first tractor 31. This causes the tractor-side drive power transfer mechanism 62 to disengage the forward transfer mechanism 63 and engage the reverse transfer mechanism 64 as shown in FIG. 6.

As described above, the conveyance speed of the continuous paper 2 by first tractor 31 is greater than the conveyance speed of the continuous paper 2 by the paper feed roller 41 when the continuous paper 2 is conveyed in reverse. The continuous paper 2 is therefore reversed with specific tension, and paper jams due to slack or creases in the paper, for example, are prevented. The reverse rotation is also transferred through the torque limiter 79 to the tractor drive shaft 33. The torque limiter 79 releases and turns freely (slips) when the transferred torque exceeds a specific limit, and torque transfer is limited to less than the torque limit. The torque limiter 79 also slips when excess torque is applied to the continuous paper 2, and tension on the continuous paper 2 is therefore limited to less than the specific limit. Problems such as excessive torque causing the sprocket holes 2*a* and 2*b* of the continuous paper 2 to disengage the first tractor pins 31*a* or second tractor pins 32*a* can therefore be prevented.

Tractor Unit Variation

In one or more embodiments described above, the first tractor 31 is attached to the positioning stop 39 disposed on the frame 35 and thereby fixed in the reference position H, but the first tractor 31 can be disposed at the reference

position H while being moveable relative to the frame **35** within a limited range in the device width direction Y. If the positioning member in this configuration has a first stop disposed on one side of the first tractor **31** in the device width direction Y with a small gap to the first tractor **31**, and a second stop on the opposite side of the first tractor **31** with a small gap to the first tractor **31**, the first tractor **31** can be disposed at the reference position H while being moveable in the device width direction Y between the first stop and the second stop. If the first tractor **31** is disposed at the reference position H while being moveable in a specific range in the device width direction Y, the sprocket holes **2***a* and **2***b* of the continuous paper **2** can also be prevented from disengaging the first tractor pins **31***a* or second tractor pins **32***a* by movement (chatter) of the first tractor **31** in the device width direction Y.

One or more embodiments of the invention can also be applied to a conveyance device **20** that conveys the continuous paper **2** by driving the paper feed roller **41**, so that the second tractor **32** can track and follow movement of the continuous paper **2** conveyed by the paper feed roller **41**. One or more embodiments of the invention can also prevent or suppress disengagement of the sprocket holes **2***a* and **2***b* of the continuous paper **2** from the first tractor pins **31***a* or second tractor pins **32***a* in the tractor unit **22**. Desirable tension on the continuous paper **2** can also be maintained during media conveyance.

It will be apparent that variations to the above specifically described embodiments may be made. Such variations are not to be regarded as a departure from the spirit and scope of the disclosure.

What is claimed is:

1. A tractor unit, comprising:

a first tractor having first tractor pins configured to be engaged in first sprocket holes formed in continuous paper to be conveyed in a conveyance direction along a first side of the continuous paper;

a second tractor having second tractor pins configured to be engaged in second sprocket holes formed in the continuous paper along a second side of the continuous paper, the second side opposite the first side across a paper width of the continuous paper;

a support shaft that extends in a transverse direction perpendicular to the conveyance direction of the continuous paper, and supports the first tractor and second tractor movably in the transverse direction;

a frame that supports the support shaft movably in the transverse direction;

a biasing member configured to bias the support shaft in the transverse direction; and

a clamping member configured to fix the second tractor on the support shaft;

the first tractor being disposed at a predetermined reference position in the transverse direction, and

in response to a movement of the support shaft in a first direction oriented from the second tractor toward the first tractor, the biasing member configured to bias the support shaft in a second direction opposite the first direction.

2. The tractor unit of claim **1**, wherein:

the support shaft is moveable between a first position and a second position displaced from the first position in the second direction; and

the biasing member does not bias the support shaft when the support shaft is in the second position.

3. The tractor unit of claim **2**, wherein:

the biasing member is a spring, and

the spring member is at a natural length thereof when the support shaft is in the second position.

4. The tractor unit of claim **1**, wherein:

the frame has a support part that supports the support shaft with an end of the support shaft passing through the support part; and

the biasing member is a coil spring disposed with an axis of the spring oriented in the transverse direction, one axial end of the biasing member connected to the support part, and the other axial end of the biasing member connected to the support shaft.

5. The tractor unit of claim **1**, wherein one of the first and second tractors is disposed between the biasing member and the other tractor.

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